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Evaluation of the South African Dorper as a terminal sire breed for growth, carcass, and palatability characteristics[1]

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ABSTRACT: The South African Dorper is an important terminal meat sire breed in Africa that was recently imported into the United States. The objective of this study was to evaluate the Dorper as a terminal meat sire breed for U.S. production. Semen from purebred Dorper sires was used to artificially inseminate Columbia ewes to produce F_1 crossbred lambs. Growth and carcass characteristics of F_1 Dorper-Columbia lambs (n = 165), F_1 Suffolk-Columbia (n = 89), and purebred Columbia lambs (n = 207) were compared based on subsets of the total number of animals. The F_1 Dorper lambs grew significantly slower (313 g·d^{-1}) and weighed less (29.8 kg) than F_1 Suffolk- (357 g·d^{-1}, 33.5 kg) and Columbia-sired lambs (328 g·d^{-1}, 31 kg) at 77 d of age. However, at a weaning age of 118 d weaning weight and ADG did not differ (P > 0.20) among sire breed groups. Postweaning growth of F_1 Dorper (239 g·d^{-1}) wether lambs did not differ from that of purebred Columbia wethers (230 g·d^{-1}) but was less than that of F_1 Suffolk lambs (259 g·d^{-1}; P = 0.09). Feed efficiency did not differ among breed types. Breed types had similar dressing percentages (53%), shoulder fat depth (2.8 mm), body wall thickness (3 cm), leg conformation score (Choice), Yield grade (2.4), and Quality grade (Choice). Weight of wholesale shoulders and racks made up approximately 38% of the carcass weight in the Columbia and F_1 Suffolk-Columbia type but only 33% in the F_1 Dorper-Columbia lambs. However, the more expensive wholesale loins from F_1 Dorpers were heavier (P < 0.01) than the other breed types. Total weights of wholesale legs were similar among F_1 Dorpers and F_1 Suffolks but were heavier than those for the purebred Columbia (P < 0.05). Percentages of total wholesale primal cuts were similar among breed types (P > 0.10). Chemical composition of the carcass did not differ significantly between breed types with a mean composition of 52% moisture, 30% lipid (ether extract), 17% protein, and 0.76% ash. Warner-Bratzler shear force values were less (P < 0.05) and sensory panel ratings for tenderness were significantly more favorable for lamb chops from Dorper sired lambs. Dorper rams can be used as terminal meat sires to produce lambs whose growth rate to 118 d of weaning age, postweaning ADG and feed efficiency, and carcass characteristics are similar to that of Suffolk crossbred lambs and purebred Columbia lambs but with a slight improvement in tenderness.

Key Words: Average Daily Gain, Composition, Feed Efficiency, Sheep

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Introduction

In the 1940s, the Dorper breed, a white-bodied sheep with a black head, was developed in the Karoo region of South Africa by crossing the imported Black Head Persian (a fat-rumped hair breed adapted to harsh, arid environmental conditions) and the British Dorset Horn. The breeding objective was to create an adapted breed capable of producing fast-growing lambs with good carcasses under grazing conditions (Milne, 2000). The Dorper has become a popular sire breed for meat characteristics in South Africa with an estimated number exceeding seven million for the breed. Studies in South Africa have reported Dorpers to have faster postweaning ADG than Dohne Merinos and Merinos (Basson et al., 1970) but similar to the Suffolk (Cloete et al., 2000). Carcass characteristics of Dorpers are favorable under South African grading standards with 36% of the carcasses grading in the most desirable classification in 1998 (Cloete et al., 2000).

Recently, the Dorper was imported into the United States to evaluate the breed as a potential easy care hair breed and/or terminal meat sire. The Dorper has

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until now not been evaluated under U.S. production systems. Therefore, the objective of this study was to evaluate the Dorper as a terminal meat sire breed in the United States.

Materials and Methods

Animals. The Dorper breed was evaluated in a crossbreeding study. The Columbia breed was chosen as the maternal breed for F_1 and for comparison as a purebred. The Columbia breed has a slightly heavier mature ewe weight (79 kg; Snowder et al., 1994) compared to the Dorper breed (72.3 kg; Cloete and De Villiers, 1987). Therefore, the intent was to use the larger mature ewe size of the Columbia breed to improve F_1 carcass characteristics when lambs are slaughtered at a typical U.S. slaughter weight. In South Africa, Dorper lambs are typically slaughtered at a live weight of 40 kg (Cloete et al., 2000); whereas in the United States lambs have an average slaughter live weight of 62 kg.

All ewes, rams, and lambs originated at the U.S. Sheep Experiment Station except the Dorper sires. Semen pellets from four purebred Dorper rams were purchased from a commercial source. Selection of Dorper semen was based solely on sires not having a common ancestor in the previous three generations. The availability of semen from unrelated Dorper rams was limited in 1997 and prevented the use of a larger number of Dorper rams. However, this small sampling widely represented the few Dorpers imported into the United States.

Columbia ewes were randomized across the three sire breed groups. One hundred and sixty-two ewes were estrous synchronized and artificially inseminated with Dorper semen via laparoscopy. Of these ewes, 107 gave birth to 172 F_1 lambs.

The F_1 Suffolk-Columbia lambs were produced by introducing ten Suffolk rams to Columbia ewes. These rams were exposed to the ewes as a multiple sire group. Suffolk rams had not been subject to selection except for breeding soundness characteristics. Sixty-four Columbia ewes gave birth to 89 F_1 Suffolk-Columbia lambs.

A total of 216 purebred Columbia lambs were born to 141 ewes and the result of natural service by 8 rams from the flock at the U.S. Sheep Experiment Station. All ewes were single sire mated. The Columbia sheep were from one of two genetic lines: a selection line with emphasis on preweaning ADG and a random breeding control line.

Preweaning Management. Lambs were born from late March through early May. Ewes with newborn lambs were removed from an outside drop lot and placed inside a covered lambing shed in a 1.5-m^2 pen, typically for 2 d, before being moved to larger outside mixing pens with other ewe and lamb(s) pairs. Within a few hours of birth, lambs were sexed, weighed, and ear-tagged. Dorper- and Suffolk-sired ram lambs were castrated by elastic banding shortly after birth. Thirteen Dorper-sired ram lambs with heavy birth weights were left intact for future research. Approximately one-third of the Columbia-sired ram lambs were also castrated by elastic banding.

In early May, lambs were moved with their dams to spring grazing on sagebrush-grass range. Ewes with their lambs were randomly assigned to one of two separate grazing sheep flocks of approximately 1,000 ewes. In late June, lambs were weighed at an average age of 77 ± 10 d. Then, flocks were trailed to mountain summer ranges where they grazed amid coniferous forests and on open slopes and meadows at elevations ranging from 2,000 to 2,900 m during July and August under traditional herding conditions. Weaning data were obtained in mid-August when lambs averaged 118 d of age.

Postweaning Management. Postweaning growth performance in a feedlot was measured only on male lambs. Daily feed intake was measured on ten wether lambs of each breed type using an automated recording and feeding system (FIRE, Osborne Industries Incorporated, Osborne, KS). The remaining male lambs (n = 96) were randomly divided into groups of 8 to 10 lambs of mixed breed types and placed into large open pens. All lambs were adjusted over a 10-d period to a pelleted commercial ration (Table 1 and 2). Lambs were given ad libitum access to feed. Lambs were vaccinated for

Table 1. Composition of commercial pelleted feed ration

Ingredient	International Feed No.	Percentage
Barley grain, ground	4-07-939	28.2
Corn, yellow dent, ground	4-02-932	10.0
Wheat middlings	4-05-205	10.0
Sunflower meal	5-04-739	24.6
Sugar beet pulp, dehydrated	4-00-669	10.0
Sugar beet molasses	4-00-668	10.0
Calcium carbonate	6-01-069	4.2
Sodium chloride	6-04-152	0.8
Calcium hydroxide	6-14-014	1.3
Ammonium chloride	8-08-814	0.5
Vitamin and trace mineral premix		0.3

Table 2. Nutrient analysis (dry basis) of commercial lamb ration

Nutrient	Amount
Crude protein, %	17.9
Fat, %	2.8
Fiber, %	9.8
TDN, %	71.0
NE maintenance, mcal/kg	1.9
NE growth, mcal/kg	1.3
Vitamin A, IU/g	25.2
Vitamin D, IU/g	2.5
Lasalocid, mg/kg	51.7
Calcium/phosphorus ratio	2.4

Clostridium perfringens types C and D at the beginning of the feeding period and were given a booster vaccination 2 wk later. Lambs were weighed every 2 wk. Feed efficiency was measured only on lambs in the automated feeding system. When lambs reached a target weight of approximately 62 kg, they were slaughtered.

Carcass Data. Lambs were humanely slaughtered at the U.S. Sheep Experiment Station or at a commercial slaughter facility (Superior Lamb Packing Corp., Dixon, CA). Carcasses were weighed prior to chilling. Dressing percent was calculated as a ratio of hot carcass weight to the 24-h fasted slaughter weight. At approximately 24 h postchilling at 2°C, carcasses were evaluated. Fat depth was measured at three locations: point of shoulder, between 12th and 13th ribs perpendicular to the longissimus dorsi, and at tail head. Body wall thickness was measured approximately 14 cm off the midline at a point approximately 2.5 cm dorsal to the diaphragm muscle. Yield and Quality Grades and leg conformation score were assigned according to USDA standards (USDA, 1992).

Fifteen carcasses from each sire breed type of uniform weight (30 ± 0.45 kg) were sorted off at the commercial packing plant to furnish data on yield of wholesale cuts. Cold carcasses were fabricated into wholesale cuts according to the protocol of the commercial plant. The foresaddle was removed by a cut behind the 4th rib. Shoulders were separated by a cut along the center of the spinal column. The foreshank and breast were removed to form a square cut shoulder. Racks were separated from loins between the 12th and 13th ribs to form an eight-rib rack. The breast was removed from the rack approximately 10 cm from the ribeye at the shoulder and loin ends. Loins were separated from the legs by a cut perpendicular to the spinal column at the 7th lumbar vertebra. The flank was removed from the loin 10 cm from the outer edge of the ribeye muscle. Kidney and lumbar fat were removed from the loin. Legs were separated down the spinal column, with the hind trotter, tail, flank, and excess pelvic fat removed. All wholesale cuts were trimmed to a smooth uniform surface fat covering of no deeper than 0.64 cm.

Chemical composition of the carcass was estimated from the right side of five carcasses of uniform weight from each breed type (30 kg). All soft tissue (muscle and fat) was manually separated from bone and cartilage. Soft tissue was then ground, using a 50 horsepower Autio 801 meat grinder (Autio, Astoria, OR), three times through a 6-mm die. Ten hand grab samples were randomly taken from the ground mix and combined into a sample of approximately 1 kg. Samples were quickly frozen and stored at −20°C until chemical analysis was performed. Prior to chemical analyses, samples were thawed at 4°C for 24 h and pulverized in liquid nitrogen. Chemical analyses (AOAC, 1990) for dry matter, nitrogen, and ash were conducted on each sample. Total lipid content was determined after extraction of lipids using organic solvents (Folch et al., 1957).

Racks from ten Dorper-sired and ten Suffolk-sired lamb carcasses chosen at random were aged at 4°C for 10 d and cut into 2.54-cm chops for fatty acid, shear force, and sensory analyses. Both a subcutaneous fat sample (10 g) and the lean portion were removed from the 12th rib, separately pulverized in liquid nitrogen, and stored frozen at −20°C for subsequent fatty acid analysis. Lipids were extracted using chloroform-methanol (Folch et al., 1957) and converted to methyl esters (Duckett et al., 2002). Fatty acid methyl esters were analyzed using an HP6890 (Hewlett-Packard, San Fernando, CA) gas chromatograph equipped with a HP7673A (Hewlett-Packard, San Fernando, CA) automatic sampler. Fatty acid methyl esters were separated, identified, and quantified according to Duckett et al. (2002).

Four chops were also removed from each rack and frozen at −20°C for subsequent Warner-Bratzler shear force and sensory analyses. Two chops were used for Warner-Bratzler shear force determination according to Duckett et al. (2000). An eight-person sensory panel was trained according to American Meat Science Association Guidelines (AMSA, 1995). The two remaining rack chops were cooked to an internal temperature of 71°C, cut into 1- × 1- × 2.54-cm cubes using a plexiglass grid (14 cm long × 12 cm wide × 4 cm deep, with slots spaced 1.25 cm apart) and served immediately to each sensory panel member. Sensory panelists marked an 8-point scale for tenderness, juiciness, and flavor for each sample (1 = extremely tough, dry, or bland; 8 = extremely tender, juicy, or intense).

Statistical Procedures. Average daily gain values from birth to the June weighing (approximately 77 d of age) and to weaning (118 d) were calculated as differences between the live weights and birth weight of the lamb divided by days-of-age. The GLM procedures of SAS (SAS Inst. Inc., Cary, NC) were used to analyze the data. The model for birth weight included fixed effects of sire breed (Columbia, Dorper, Suffolk), age of dam (2, 3, 4, 5, 6, 7), litter size (1, 2, 3), and sex of lamb (ram, wether, ewe). The models for ADG and lamb weight at 77 d or weaning (118 d) also included fixed effects of grazing group (1, 2) and litter size at day of weighing rather than litter size at birth to account for sibling lamb death. Age at weighing was included as a linear covariate for 77- and 118-d weight. Preliminary analyses indicated first-order interactions among fixed effects were not significant.

Postweaning performance for weight and ADG was also analyzed by GLM procedures. Sire beed type was the only fixed effect for the analyses of days on feed, initial live weight, final live weight, and feed efficiency. The model for postweaning ADG included the fixed effects of breed type and feeder system (automated, feed lot). Initial weight on test and number of days on feed were included as linear covariates when analyzing ADG and feed efficiency.

Sire breed was modeled as a fixed effect for all slaughter, carcass and cutability traits, and chemical composi-

Table 3. Numbers of lambs and least squares means for growth traits by sire breed group

Sire breed[a]	N[b]	Birth wt, kg	77-d wt, kg	ADG, $g \cdot d^{-1}$ (birth to 77 d)	118-d weaning wt, kg	ADG, $g \cdot d^{-1}$ (birth to 118 d)
Columbia	207	5.4 ± 0.14	31.0 ± 0.75[x]	328 ± 9.0[x]	40.1 ± 0.37	292 ± 2.91
Dorper	165	5.5 ± 0.14	29.8 ± 0.80[y]	313 ± 9.6[y]	39.2 ± 0.55	283 ± 4.40
Suffolk	89	5.7 ± 0.18	33.5 ± 1.51[z]	357 ± 18.2[z]	40.9 ± 1.64	297 ± 12.89

[a]Lambs born and reared by Columbia ewes bred to one of three sire breeds.
[b]N = number of lambs born and surviving to weaning.
[x,y,z]Within a column, means without a common superscript differ ($P < 0.05$).

tion values. Fasted slaughter weight was included as a linear covariate for carcass measures of fat depth, body wall thickness, leg conformation score, Yield Grade, and Quality Grade.

Fatty acid, shear force, and sensory data were analyzed using the GLM procedure of SAS with sire breed in the model. Differences due to sire breed were compared using the Student *t*-test procedure.

The numbers of observations for pre- and postweaning growth performance for sire breed groups were unequal. Because multiple comparisons of unequal cell sizes can result in counterintuitive results, two statistical tests were used to compare means of the sire breeds. The Tukey-Kramer method (Hayter, 1984) was used as provided in SAS GLM. Least squares means were compared using the PDIFF option of GLM. The Tukey and PDIFF procedures identified similar significant differences between sire breed effects. Therefore, least squares means with their standard errors are reported.

Results and Discussion

All fixed effects in the GLM models for ADG and weaning weight were significant. A summary for preweaning growth traits is presented in Table 3. Birth weight did not differ among pairs of the three sire breed groups. The national average in South Africa for birth weight for Dorpers is 4.4 kg (Schoeman, 2000), but when nutrition and management conditions are more favorable, the average birth weight for Dorpers can be heavier (5.0 kg; Schoeman and Van De Merwe, 1994).

At approximately 77 d of age, the effect of sire breed was significant for growth rate and body weight. Dorper-sired F_1 lambs grew more slowly and weighed less ($P < 0.05$) than Suffolk and Columbia-sired F_1 lambs. Suffolk-sired lambs had a higher ADG and were heavier than Columbia lambs ($P < 0.05$). The ADG of the F_1 Dorper lambs (313 g) was similar to that reported for purebred Dorper lambs weaned at 77 d after grazing on supplemented natural pastures in South Africa (290 g; Buitendag, 1985). However, the ADG for F_1 Dorper lambs in this study exceeds the average of several research reports for purebred Dorper lambs (248 g; Cloete et al., 2000). These differences in growth rate between F_1 and purebred Dorpers are likely influenced by hybrid vigor and by environmental and management circumstances.

Differences were not detected ($P > 0.20$) among sire breed groups for weaning weight or ADG at an average weaning age of 118 d. Average daily gain and weaning weight of Dorper-sired F_1 lambs (283 g and 39.2 kg, respectively) were similar to those for purebred Dorpers at 138 d of age reared on natural pasture in South Africa (270 g and 41.3 kg, respectively; Cloete and De Villiers, 1987). Similarly, Schoeman (2000) reported unpublished data from Snyman that the average 120-d weaning weight for purebred Dorpers was 33.4 kg.

Postweaning growth varied among sire breed groups (Table 4). Purebred Columbia wethers grew slower than F_1 Suffolk-sired wether lambs ($P < 0.05$). The ADG of F_1 Dorper-sired wether lambs was intermediate to purebred Columbia and F_1 Suffolk-sire wether lambs. The F_1 Suffolk lambs grew faster than the F_1 Dorper lambs ($P = 0.09$). Slower growth for purebred Dorper ewe lambs fed a pelleted commercial ration from 100 to 200 d of age was previously reported (180 $g \cdot d^{-1}$, Schoeman et al., 1993).

Feed efficiency ratios did not differ among sire breed groups with an average of 0.11. Dorper ewe lambs from 100 to 200 d of age were reported previously to have

Table 4. Numbers of wether lambs, average days on feed, and least squares means for postweaning growth and feed efficiency traits by sire breed group

Sire breed	N	Days on feed	Initial wt, kg	Final wt, kg	ADG, $g \cdot d^{-1}$	Efficiency ratio[a]
Columbia	20	59 ± 3.9[y]	48.7 ± 0.93[y]	62.6 ± 0.75[y]	230 ± 11[y]	0.10 ± 0.01
Dorper	68	66 ± 2.2[y,z]	50.2 ± 0.50[y]	65.0 ± 0.40[z]	239 ± 7[y,z]	0.12 ± 0.01
Suffolk	38	69 ± 5.4[z]	43.4 ± 0.68[z]	63.1 ± 0.54[y]	259 ± 10[z]	0.11 ± 0.01

[a]Means for efficiency ratio were based on 10 lambs per breed type.
[y,z]Within a column, means without a common superscript differ ($P < 0.05$).

consumed 43% more feed, were 12% less efficient at feed conversion but had a 40% advantage in ADG when compared to two synthetic composite breeds with ½ and ⅜ of genes from Finnish Landrace sheep (Schoeman et al., 1993).

Few significant differences among sire breed groups for carcass characteristics were found (Table 5). Slaughter weight was greater ($P < 0.05$) for Dorper-sired lambs than Columbia- or Suffolk-sired lambs, which were similar. Sire breed groups were similar for dressing percentage, shoulder fat depth, body wall thickness, leg conformation score, yield grade, and quality grade. Subcutaneous fat depth at the 13th rib was greater ($P < 0.05$) for Dorper-sired carcasses than Suffolk-sired with Columbia-sired carcasses being intermediate. Fat depth at the tail head was greater ($P < 0.05$) for Dorper and Suffolk sired F_1 carcasses than for purebred Columbia carcasses. Moss et al. (2000) reported larger leg scores and greater carcass fatness for Dorper-Rambouillet compared to Rambouillet. Dorper sheep are early maturing and tend to put fat on at lighter weights when compared to most other breeds found in South Africa, especially under intensive or favorable environmental conditions (Cloete et al., 2000). Other studies have also reported increased carcass fat deposition in Dorper and Dorper crossbred lambs (Moss et al., 2000; Webb and Casey, 1995).

Differences in wholesale cuts as a percentage of carcass weight are shown by sire breed in Table 6. Square-cut shoulders made up a smaller percentage ($P < 0.05$) of the carcass from Dorper-sired lambs than of Columbia- or Suffolk-sired lambs, which were similar. Percentage of carcass weight as wholesale racks from Dorper-sired lamb carcasses were similar to those from Suffolk-sired lamb carcasses but were significantly smaller than those from Columbia-sired lamb carcasses. However, the percentage of wholesale loins was larger ($P < 0.05$) for Dorper-sired lamb carcasses than the other two sire breed groups. Legs as percentages of carcass weight and total major wholesale cuts were similar for the sire-breed groups. These small differences in percentage wholesale cuts indicate little, if any, economic difference between carcasses based on sire breed type.

Moisture, protein, lipid, and ash content of soft tissue by breed are shown in Table 7. Chemical composition was similar between breed types. The lack of differences among breed types for lipid content does not agree with observed differences in subcutaneous and tailhead fat depths observed on carcasses.

Pelts from F_1 Dorper lambs were discarded by the commercial abattoir because of inherent black spots on the hide, which resulted in a loss of $14.00 per animal. Similar discounts for Dorper crossbred pelts in the United States have been previously reported (Moss et al., 2000). The use of White Dorper rams (genetically white color) should resolve this issue. Some promoters of the Dorper breed claim Dorper leather is of greater quality compared to other sheep leathers and that a

Table 5. Number of wether lambs and least squares means by sire breed group for slaughter and carcass traits adjusted to a common fasted slaughter weight

Sire breed	N	Slaughter wt, kg	Carcass wt, kg	Dressing percent	Fat depth, mm			Body wall, cm	Leg score[a]	Yield grade	Quality grade[b]
					Shoulder	13th rib	Tail head				
Columbia	19	61.1 ± 0.99^{y}	30.2 ± 0.49^{y}	53.4 ± 0.57	2.8 ± 0.37	$6.7 \pm 0.38^{y,z}$	15.3 ± 0.13^{y}	2.9 ± 0.15	11.4 ± 0.14	2.4 ± 0.11	8.4 ± 0.28
Dorper	68	64.1 ± 0.51^{z}	32.5 ± 0.25^{z}	52.9 ± 0.29	2.9 ± 0.21	7.1 ± 0.21^{y}	17.6 ± 0.07^{z}	3.2 ± 0.08	11.6 ± 0.08	2.7 ± 0.06	8.8 ± 0.15
Suffolk	38	60.9 ± 0.70^{y}	30.6 ± 0.35^{y}	53.5 ± 0.40	2.7 ± 0.27	6.4 ± 0.28^{z}	16.9 ± 0.09^{z}	2.9 ± 0.11	11.8 ± 0.11	2.3 ± 0.08	8.5 ± 0.20

[a]Leg conformation score based on a numeric scale of 10 = low Choice; 11 = average Choice; 12 = high Choice.
[b]Quality grade based on a numeric scale of 7 = low Choice; 8 = Choice; 9 = high Choice; 10 = low Prime; 11 = Prime.
[y,z]Within a column, means without a common superscript differ ($P < 0.05$).

Table 6. Least squares means by sire breed group for percentages of individual and total wholesale cuts of cold carcass weight

Sire breed	N	Shoulders	Racks	Loins	Legs	Total
Columbia	15	24.4^{y}	10.4^{y}	10.8^{y}	30.4	76.1
Dorper	15	23.3^{z}	9.9^{z}	11.8^{z}	31.2	76.2
Suffolk	15	24.0^{y}	$10.0^{y,z}$	10.9^{y}	30.9	75.8
SE		0.19	0.14	0.14	0.25	0.31

[y,z]Within a column, means without a common superscript differ ($P < 0.05$).

premium should be paid for a Dorper pelt. However, a comparison of Dorper pelts with pelts from several other breeds did not find differences in measures of leather quality (Synman and Jackson-Moss, 2000). Similarly, characteristics of leather quality were not different between Dorper- or Suffolk-sired F_1 lamb pelts (Snowder, unpublished data).

Fatty acid composition of longissimus muscle from Dorper- and Suffolk-sired lamb carcasses is shown in Table 8. Muscle tissue from Dorper-sired lambs had less ($P < 0.05$) palmitic (16:0) and palmitoleic (16:1) acids. Stearic acid (18:0) concentration was 6.8% greater ($P < 0.05$) in Dorper-sired lamb. Fisher et al. (2000) and Sanudo et al. (2000) both reported differences in concentrations of intramuscular stearic and palmitic acids among breeds (Welsh Mountain, Soay, and Suffolk; Spanish Merino, Rasa Argonesa, and Welch Mountain). Stearic acid concentration is highly correlated with flavor acceptability (r = 0.62; Sanudo et al., 2000). Conjugated linoleic acid (*cis*-9, *trans*-11 isomer) was 21% greater ($P < 0.05$) in Dorper-sired lamb muscle. Small differences between breeds for conjugated linoleic acid concentration (mg/g fat) in other ruminant species were previously reported (Mir et al., 2000; Lawless et al., 1999). Other individual fatty acids (capyrlic [10:0], lauric [12:0], myristic [14:0], myristoleic [14:1], pentadecyclic [15:0], margaric [17:0] oleic [18:1], linoleic [18:2], linolenic [18:3], and arachidonic [20:4]) were not different for sire breeds. Monounsaturated fatty acid percentage was lower ($P < 0.05$) in Dorper-sired lamb due to reductions in myristoleic and oleic acids and lower concentration of palmitoleic acid. Percentage of odd-chain fatty acid was greater ($P < 0.05$) in longissimus of Dorper-sired than for Suffolk-sired lambs. The ratio of hypercholesterolemic (10:0, 12:0, 14:0, and 16:0) to neutral (18:0) and hypocholesterolemic (monounsaturated and polyunsaturated fatty acids) fatty acids was significantly less (more desirable) for Dorper-sired lambs due to reduction in palmitate and increase in stearate. Saturated and polyunsaturated fatty acid contents did not differ due to sire breed. Total lipid content was less ($P < 0.05$) for Dorper-sired than Suffolk-sired lambs. Cholesterol content did not differ due to sire breed.

Fatty acid composition of subcutaneous adipose tissue is shown in Table 9 by sire breed. Total percentages of odd-chain fatty acids, pentadecyclic acid and margaric acid were greater ($P < 0.05$) for Dorper-sired than Suffolk-sired lambs. Webb and Casey (1995) also reported greater concentrations of margaric acid in subcutaneous fat from Dorper vs South African Mutton Merino lambs. Concentration of palmitic acid was less ($P < 0.05$) and stearic acid concentration was more ($P < 0.05$) for Dorper-sired lambs. These changes in palmitic and stearic acid are similar to those reported for intramuscular lipid and would suggest elevated adipose elongase activity (enlongation of palmitic acid to stearic acid) or more extensive ruminal biohydrogenation by Dorper-sired lambs. In contrast, Webb and Casey (1995) reported no differences in palmitic or stearic acid contents of subcutaneous adipose tissue due to breed

Table 7. Numbers of lambs and mean chemical composition (%) of carcass soft tissue by sire breed group[a]

Sire breed	N	Moisture	Protein	Lipid	Ash
Columbia	5	52.7	16.7	30.3	0.72
Dorper	5	53.2	17.5	29.1	0.78
Suffolk	5	51.2	17.0	31.8	0.75
SE		1.23	0.33	1.39	0.02

[a]Within a column, means did not differ ($P > 0.05$).

Table 8. Fatty acid composition from longissimus muscle (g/100 g lipid) by sire breed group

Fatty acid	Dorper	Suffolk	SEM
N	10	10	
10:0	0.15	0.16	0.01
12:0	0.17	0.15	0.01
14:0	2.56	2.63	0.10
14:1 c9	0.08	0.10	0.01
15:0	0.30	0.28	0.01
16:0	24.27^{y}	25.45^{z}	0.32
16:1 c9	1.36^{y}	1.59^{z}	0.04
17:0	0.98	0.92	0.03
18:0	17.66^{y}	16.54^{z}	0.33
18:1 c9	42.40	43.02	0.30
18:2 c9c12	6.06	5.62	0.26
18:2 c9t11 (CLA)	0.51^{y}	0.42^{z}	0.02
18:3 c9c12c15	0.18	0.19	0.01
20:4	1.23	0.99	0.08
SFA[a]	44.82	44.93	0.44
OCFA[a]	1.29^{y}	1.19^{z}	0.03
MUFA[a]	43.85^{y}	44.71^{z}	0.29
PUFA	7.68	7.08	0.30
Ratio[b]	0.386^{y}	0.410^{z}	0.008
Total Lipid, g/100 g	3.52^{y}	4.30^{z}	0.23
Cholesterol, mg/100 g	60.55	60.60	1.28

[a]SFA = saturated fatty acids, OCFA = odd-chain fatty acids, MUFA = monounsaturated fatty acids, and PUFA = polyunsaturated fatty acids.

[b]Ratio = ratio of hypercholesterolemic (10:0, 12:0, 14:0, 16:0) to neutral (18:0) and hypocholesterolemic (MUFA and PUFA) fatty acids.

[y,z]Means in the same row without a common superscript differ ($P < 0.05$).

Table 9. Fatty acid composition of subcutaneous adipose tissue (g/100 g lipid) by sire breed group

Fatty acid	Dorper	Suffolk	SEM
N	10	10	
10:0	0.19	0.21	0.01
12:0	0.19	0.14	0.02
14:0	3.26	3.14	0.17
14:1 c9	0.05	0.04	0.01
15:0	0.91^y	0.79^z	0.04
16:0	23.64^y	25.10^z	0.48
16:1 c9	1.07	1.15	0.04
17:0	3.07^y	2.55^z	0.15
18:0	21.50^y	20.01^z	0.52
18:1 c9	38.89	39.31	0.39
18:2 c9c12	4.11	4.58	0.20
18:2 c9t11 (CLA)	0.51	0.51	0.03
18:3 c9c12c15	0.24	0.18	0.02
20:4	0.12	0.14	0.01
SFA[a]	48.78	48.60	0.70
OCFA[a]	3.98^y	3.35^z	0.18
MUFA[a]	40.01	40.50	0.38
PUFA	5.67	5.96	0.25
Ratio[b]	0.41	0.43	0.01

[a]SFA = saturated fatty acids, OCFA = odd-chain fatty acids, MUFA = monounsaturated fatty acids, and PUFA = polyunsaturated fatty acids.
[b]Ratio = ratio of hypercholesterolemic (10:0, 12:0, 14:0, 16:0) to neutral (18:0) and hypocholesterolemic (MUFA and PUFA) fatty acids.
[y,z]Means in the same row without a common superscript differ ($P < 0.05$).

type. Other individual fatty acids (capyrlic, lauric, myristic, myristoleic, palmitoleic, oleic, linoleic, linolenic, and arachidonic acids) did not differ due to sire breed. Similarly, Webb and Casey (1995) reported only a few differences in the fatty acid composition of subcutaneous adipose tissue in comparisons between Dorper and South African Mutton Merino. Conjugated linoleic acid content of subcutaneous adipose tissue did not differ between sire breeds. Saturated, monounsaturated, and polyunsaturated fatty acid percentages and ratio of hypercholesterolemic to hypocholesterolemic fatty acids for subcutaneous adipose tissue were similar between sire breeds.

Warner-Bratzler shear force of rib chops was 30% less ($P < 0.05$; Table 10) for Dorper-sired than Suffolk-sired lambs. Sensory panel ratings for tenderness were higher ($P < 0.05$) and more desirable for Dorper-sired lambs. Chops from Dorper-sired lambs were also scored higher ($P < 0.05$) for juiciness. Flavor intensity ratings were similar between sire breeds. Cramer et al. (1970a) reported increased flavor intensity with increased fineness of the wool for the three breed types (Rambouillet, Targhee, and Columbia). In a second study (Cramer et al., 1970b), Romney, Hampshire, Columbia, Rambouillet, and Merino breeds had similar intensities of flavor. Other researchers (Fox et al., 1962; Dransfield et al., 1979; Crouse et al., 1981) have reported no significant differences in lamb flavor due to breed or sire breed. Additional research is currently underway to further examine palatability differences of Dorper-sired lamb.

Table 10. Sensory evaluation of rib chops from Suffolk- or Dorper-sired lambs

Measure	Dorper	Suffolk	SEM
N	10	10	
Warner-Bratzler shear force, kg	2.80^y	3.98^z	0.39
Trained sensory panel ratings[a]			
Tenderness	7.10^y	5.68^z	0.18
Juiciness	5.78^y	5.24^z	0.18
Flavor Intensity	5.53	5.26	0.14

[a]Sensory ratings (8 = extremely tender, juicy, or intense; 1 = extremely tough, dry, or bland).
[y,z]Means in the same row without a common superscript differ ($P < 0.05$).

Potential limitations to this study should be noted. Only a limited number of Dorper rams were available for this study in 1997. Subsequent importation of Dorper sheep has allowed for increased sampling which may or may not alter the conclusions of this study. Also, the sire within breed effect could not be evaluated by the statistical model because the Suffolk rams were multiple sire mated. Not accounting for the sire within breed effect may result in smaller standard errors of the contrasts that are used to calculate the P values.

These preliminary findings infer that the South African Dorper may be a useful terminal sire breed for U.S. lamb production. Increasing interest in hair sheep production may consider the Dorper breed. Future and current studies of the Dorper breed will contribute further to its characterization for U.S. production and consumer acceptability.

Implications

Dorper rams can be used as terminal sires to produce lambs with growth rates, postweaning feed efficiency, and carcass traits similar to those of Suffolk-sired lambs and of purebred Columbia lambs. Some improvement in tenderness of cooked lamb can be achieved with Dorper-sired lambs, although most lamb is considered tender. Flavor and fatty acid composition will not be greatly improved with Dorper-sired lambs. Economical loss associated with the spotted Dorper pelt can be overcome by using white Dorper sires.

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